A preliminary survey of the freshwater mussels of the Bayfield River watershed and nearby Lake Huron tributaries

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ABSTRACT

Morris, T. J., McNichols-O'Rourke, K. A. and Robinson, A. 2012. A preliminary survey of the freshwater mussels of the Bayfield River watershed and nearby Lake Huron tributaries. Can. Manuscr. Rep. Fish. Aquat. Sci. 2993: v + 22 p.

Surveys of the freshwater mussels (Unionidae) of the Bayfield River watershed and smaller nearby Lake Huron tributaries in southwestern Ontario were undertaken by Fisheries and Oceans Canada in 2007 and 2008, respectively. Eighteen sites were sampled along the Bayfield River, from both the main channel and its tributaries. A total of 1385 animals were found, representing 16 species. The dominant species in the Bayfield River watershed was *Pyganodon grandis*, which occurred at over half of the sites surveyed, and represented 44% of all mussels found. Two provincially listed mussel Species at Risk, *Quadrula quadrula* and *Villosa iris*, were detected. A single *Q. quadrula* was observed whereas *Villosa iris* occurred at 28% of sites and represented 2% (33 of 1385) of all mussels found. A total of 19 Lake Huron tributary sites were sampled both north and south of the Bayfield River. A total of nine mussels, representing two species, were found at one site. The dominant species was also *Pyganodon grandis*. No Species at Risk were detected during these surveys.

RÉSUMÉ

Morris, T. J., McNichols-O'Rourke, K. A. and Robinson, A. 2012. A preliminary survey of the freshwater mussels of the Bayfield River watershed and nearby Lake Huron tributaries. Can. Manuscr. Rep. Fish. Aquat. Sci. 2993: v + 22 p.

Des études des moules d'eau douce (famille des unionidés) du réseau hydrographique de la rivière Bayfield et de plus petits tributaires à proximité du lac Huron ont été réalisées dans le sud-ouest de l'Ontario par Pêches et Océans Canada en 2007 et en 2008, respectivement. Dix-huit sites ont été échantillonnés le long de la rivière Bayfield, tant sur le cours principal que les tributaires. En tout, 1 385 animaux aquatiques ont été découverts, représentant 16 espèces différentes. La moule de type *Pyganodon grandis*, est l'espèce prédominante dans le réseau hydrographique de la rivière Bayfield. On l'a trouvée dans plus de la moitié des sites à l'étude et elle représentait 44 % de l'ensemble des moules découvertes. Deux espèces figurant dans la liste des espèces menacées, la moule *Quadrula quadrula* et la moule *Villosa iris*, ont été répertoriées. Une seule moule *Q. quadrula* a été observée alors que l'on a trouvé des moules *Villosa iris* dans 28 % des sites ayant fait l'objet de relevés et cette dernière espèce représentait 2 % (33 des 1385) moules trouvées. En tout, 19 sites ont été échantillonnés dans des tributaires du lac Huron tant au nord qu'au sud de la rivière Bayfield. Neuf moules, représentant deux espèces, ont été répertoriées en tout à un emplacement. Dans ce cas, l'espèce *Pyganodon grandis* était également l'espèce prédominante. Aucun représentant d'une espèce menacée n'a été répertorié pendant ces études.

1.0 INTRODUCTION

Freshwater mussels play a vital role in the functioning of aquatic ecosystems. They are involved in several water column and sediment processes, provide habitat for algae and invertebrates, and transfer energy from aquatic to terrestrial environments via predation (Neves and Odom 1989, Newton et al. 2011, Vaughn and Hakenkamp 2001). Despite their importance they are among North America's most imperilled species (Ricciardi et al. 1998). Approximately 72% of native North American freshwater mussels are considered threatened, endangered or extinct (Williams et al. 1993). In Canada, there are over 50 species of freshwater mussels, most of which occur in Ontario (Metcalfe-Smith and Cudmore-Vokey 2004). More than 65% of Canada's native freshwater mussels are in need of conservation (Metcalfe-Smith et al. 2005). Therefore, it is vital that surveys are completed to determine mussel distributions so that the appropriate steps are taken to ensure the survival and recovery of these species.

The Bayfield River watershed and other Lake Huron tributaries are located in southwestern Ontario (Figures 1, 2). The Bayfield River watershed consists of the main channel, and two tributaries, Trick's Creek and Bannockburn River. It is a relatively small basin draining 497 km^2, and is under the management of the Ausable-Bayfield Conservation Authority along with the Lake Huron tributaries. The headwaters of the Bayfield River begin near Dublin and enter Lake Huron at Bayfield, after flowing through Seaforth, Clinton, and meeting the Bannockburn River north of Varna. The Lake Huron tributaries consist of various gullies, drains and rivers that extend inland generally less than 10 km from the Lake. The majority of sites surveyed in 2008 were located between Grand Bend in the south and Goderich in the North, with the exception of four sites that were located north of Goderich. Most of these systems begin in a shared moraine that runs parallel to the eastern shore of Lake Huron and consist largely of till moraines and plains (Chapman and Putnam 1984). Land use in both the Bayfield and Lake Huron drainages is primarily agricultural, with soil generally composed of clay and silt loams (Veliz et al. 2007).

There are no historical freshwater mussel records for either the Bayfield River or the numerous Lake Huron tributaries. However, populations of the federally Endangered *Epioblasma torulosa rangiana* (Northern Riffleshell), *Epioblasma triquetra* (Snuffbox), and *Ptychobranchus fasciolaris* (Kidneyshell) as well as *Lampsilis fasciola* (Wavyrayed Lampmussel), a species of Special Concern, are located in the Ausable River to the south (ARRT 2005). In addition, the largest population of the provincially Threatened *Villosa iris* (Rainbow Mussel) is located in the Maitland River to the north (COSEWIC 2006a). Therefore, there is the potential for mussel Species at Risk (SAR) to occur in these unsearched watersheds. Consequently, surveys were conducted in the Bayfield River watershed and other Lake Huron tributaries by Fisheries and Oceans Canada in 2007 and 2008 to determine species richness and abundance.

2.0 METHODS

Eighteen sites in the Bayfield River watershed (Figure 1, Appendix A), including four sites on Bannockburn River and one site on Trick's Creek, were surveyed in July 2007. Nineteen sites in the Lake Huron tributaries (Figure 2, Appendix B) were surveyed in June and July, 2008. Each site was surveyed visually using the intensive

timed-search technique described by Metcafe-Smith et al. (2000). At each site the substrate was surveyed to the maximum wading depth using visual (viewing boxes, naked eye) and tactile (excavation using hands and scoops) techniques. A team of at least three people moved parallel to the river bank for a total of 4.5 person-hours of searching per site. During the surveys all live animals were removed from the substrate and placed in a mesh diver's bag. At the end of the sampling period, mussels from all collectors were combined, identified, measured, sexed (if possible) and returned to the river.

In addition to the biological data on the mussel community, several physical and environmental variables were also recorded at each site. These variables included substrate composition, water clarity, length of reach, mean stream depth and width. Definitions of substrate sizes were modified from Wentworth (1922): boulder (>250 mm in diameter), rubble (60-250 mm), gravel (20-50 mm), sand (<2 mm) and "other" material (mud, muck, silt, and detritus).

3.0 RESULTS

3.1 ABIOTIC FACTORS

Table 1 provides a summary of the physical data collected during the surveys of the Bayfield River watershed. These data are not meant to address issues relating to species microhabitat preferences, but rather to provide a general description of the site and assist future researchers in locating the exact site should further surveys take place. Sites BF3-1 and BF3-2 were surveyed, however, no physical data regarding the sites were collected (with the exception of water clarity and site length at BF3-2). In general, the Bayfield River watershed was characterized by an abundance of very coarse substrate. In most cases, boulder and rubble material constituted the majority of the substrate with means (± standard error) of 16.5 (± 4.4) and 52.2 (± 5.4), respectively. At least some gravel was located at 15 of the 16 sites where physical data were collected, and over half of these also had some sand present. The Bayfield River is generally a low turbidity system as water clarity was usually high providing visibility throughout the entire water column (Table 1). Site length and mean width ranged from 100-1000 m and 5-25 m, respectively and mean depth surveyed was 0.32 m.

Of the 19 sites identified in the Lake Huron tributaries, two could not be surveyed (Table 2). Site #4 was not searched as access was severely limited and upstream movement was not possible making the survey methods ineffective. Site #11 was dry and as a result was not sampled. Site PG5 was surveyed, however, the total search effort was limited to three person-hours (rather than 4.5) due to the overlap with this site and PG1 (Appendix B). The Lake Huron tributary sites were quite variable with respect to substrate composition and turbidity. Substrate composition varied from large proportions of rubble, ranging from 0-57.5% to large proportions of muck, mud, silt, and detritus (listed as "other" in Table 2) ranging from 15-85%. Water clarity ranged from "very poor" (zero visibility) at one site to "clear" (entire water column visible) at five sites throughout the tributaries (Table 2). The site length ranged from 300-1495 m and mean width ranged from 0.75-8 m. The mean depth surveyed was 0.34 m.

3.2 FRESHWATER MUSSEL COMMUNITY

A total of 1385 animals representing 16 species were collected during the Bayfield River survey (Table 3). Of the 18 sites surveyed, four had no live mussels. Total abundance at the remaining sites was highly variable ranging from a low of one individual at two sites (BF2-2, BF2-3), to a high of 592 individuals at one site (BF3-3; Table 3). Similar to patterns in abundance, richness was highly variable across sites ranging from a low of one species at three sites (BF2-2, BF2-3, BF3-4) where only *Lampsilis siliquoidea* was recorded, to a high of 12 species at one site (BF1-2). The two dominant species in the watershed were *Lampsilis siliquoidea* and *Pyganodon grandis* (Table 4). Both of these species were abundant at site BF3-3 where sampling was halted after 2.25 person-hours. A total of 75 *L. siliquoidea* and 203 *P. grandis* were collected and measured – these numbers were then multiplied by two in order to determine an estimate of the total number that would have been observed during the entire sampling period. *Lampsilis siliquoidea* was the most widely distributed species (78% of the sites), occurring at 10 sites in the main stem of the Bayfield River and four in the Bannockburn River. It varied in abundance from one at three sites (BF2-2, BF2-3, BF4-4) to approximately 150 at one site (BF3-3), making it the second most common species (33% relative abundance). Of the 460 *L. siliquoidea* collected, 233 males and 126 females were identified making the male to female ratio 1.8:1 (not all individuals were sexed). Figure 3 shows the length frequency distribution for these males and females. It also shows the differences in sizes between the males, which had a maximum length of 140 mm, and the females, which had a maximum length of 115 mm.

Pyganodon grandis was found at 55% of the sites, seven of which occurred in the main stem of the Bayfield River and three of which occurred in the Bannockburn River (Tables 3 and 4). It varied in abundance from two at two sites (BF2-4, BF4-2) to approximately 406 at one site (BF3-3), making it the most abundant species (44% relative abundance). Figure 4 shows the size frequency distribution for 409 *Pyganodon grandis*.

Two mussel SAR were observed during the Bayfield River watershed surveys: (1) *Quadrula quadrula* (Mapleleaf Mussel); and (2) *Villosa iris* (Rainbow Mussel). A single *Q. quadrula* was found at the most downstream site in the main stem of the Bayfield River (BF1-2; Figure 5). A total of 33 *V. iris* were found at three sites in the main stem of the Bayfield River (BF2-4, BF3-2, BF3-3) and two sites in Bannockburn River (BF4-1, BF4-2; Figure 6). Although this species is sexually dimorphic, not all individuals were sexed, therefore, Figure 7 shows the length frequency of all 33 individuals found. Of these 33 individuals, 19 were identified as males and six were identified as females.

In total, nine animals representing two species, *Pyganodon grandis* and *Strophitus undulatus* were collected during the Lake Huron tributaries survey (Table 5). Two sites, #4 and #11, were not surveyed because poor environmental conditions made the sites uninhabitable for mussels (Appendix B). Of the remaining 17 sites, mussels were observed at just one site #21. The dominant species (eight of nine individuals) at this site was *Pyganodon grandis* (89% relative abundance). The remaining individual was *Strophitus undulatus*.

4.0 DISCUSSION

The 2007 and 2008 surveys confirmed the presence of 16 species of mussels in the Bayfield River watershed, including two species that are provincially protected under the *Endangered Species Act*. Some of common mussel species, for example, *L. siliquoidea* and *P. grandis*, appear to be healthy as multiple size classes in the length frequency distributions suggest that reproduction and recruitment are occurring. Two mussel SAR (*Q. quadrula* and *V. iris*) were detected during these surveys and these represent the first records for these species in the Bayfield River watershed.

4.1 *Quadrula quadrula* (Mapleleaf Mussel)

Quadrula quadrula was assessed as Threatened in Ontario and Endangered in Manitoba by the Committee on the Status of Endangered Wildlife in Canada in 2006 (COSEWIC; COSEWIC 2011). It is now legally designated as Threatened by the Ontario Ministry of Natural Resources under the *Endangered Species Act* (OMNR 2011). Historically this species occurred in the Detroit, Sydenham, Thames, Grand, Welland and Niagara rivers as well as Lake Erie and Lake St. Clair, however, it has been lost from approximately 49% of this historical range in Ontario (COSEWIC 2006b). The decline has been attributed to habitat loss and degradation, invasive species, and pollution (urban, industrial, municipal, and agricultural; COSEWIC 2006b). Currently, *Q. quadrula* is found in the Ausable, Sydenham (North and East branch), Thames, Grand and Welland rivers (COSEWIC 2006b, Morris et al. 2012). This is the first time that *Q. quadrula* has been reported in the Bayfield River and this record represents the current northern limit of its distribution in Ontario. Since only one individual was found, further surveys are required to determine the full extent of this population.

4.2 *Villosa iris* (Rainbow Mussel)

As hypothesized, *V. iris* was detected in the Bayfield River, though not in high abundance. This species was assessed as Endangered by COSEWIC in 2006 (COSEWIC 2011). It is now legally designated as Threatened by the Ontario Ministry of Natural Resources under the *Endangered Species Act* (OMNR 2011). Historically, this species was widespread and occurred in the Ausable, Bayfield, Detroit, Grand, Maitland, Moira, Niagara, Salmon, Saugeen, Sydenham, Thames and Trent rivers, as well as lakes Huron, Ontario, Erie and St. Clair. Evidence suggests that *V. iris* has been extirpated from the lower Great Lakes and connecting channels (except for the Lake St. Clair delta), however, extant populations continue to occur in the rivers listed above (COSEWIC 2006a). Declines have been primarily attributed to the invasive Zebra Mussel, but also include sediment and nutrient loading and toxic substances from both urban and agricultural activities (COSEWIC 2006a). Prior to this survey, the only record of *V. iris* from this river consisted of a single fresh valve collected in 2005 (COSEWIC 2006a). The present study has confirmed the existence of an extant population demonstrating a size distribution indicative of ongoing reproduction and recruitment.

Unlike the Bayfield River watershed, other Lake Huron tributaries surveyed during this work do not appear to support significant populations of mussels. Reasons for this may include a lack of suitable habitat, water quality, and host fish (most freshwater mussels are parasitic on fish species; Watters et al. 2009).

5.0 CONCLUSION

This is the first official survey for unionid fauna in the Bayfield River watershed and Lake Huron tributaries. As such, it represents a collection of baseline data, which will be useful for future comparisons. Further surveys are required to properly assess and monitor the status of the two mussel Species at Risk observed as well as any other species that may not have been detected during these preliminary surveys.

6.0 ACKNOWLEDGEMENTS

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Table 1. Physical characteristics of the sites surveyed in the Bayfield River watershed in 2007. Substrate types are modified from Wentworth (1922): boulder is >250 mm in size, rubble is between 60-250 mm in size, gravel is between 20-50 mm in size, and sand is <20 mm in size. "Other" includes muck, mud, silt, and detritus. N/A refers to data that were not collected.

Site	Substrate (%)					Water clarity	Site length (m)	Mean width (m)	Mean depth searched (m)	Stream morphology (%)		
	Boulder	Rubble	Gravel	Sand	Other					Riffle	Run	Pool
BF1-1	60	35	5	0	0	0.4m	500	15	0.2	60	10	30
BF1-2	20	30	30	0	20	0.35m	350	25	1	10	60	30
BF1-3	50	45	5	0	0	0.4m	1000	15	0.3	40	50	10
BF2-1	5	70	5	0	20	clear	200	20	0.2	90	0	10
BF2-2	10	50	15	10	15	clear	175	15	0.15	50	0	50
BF2-3	10	55	20	5	10	clear	250	15	0.35	50	0	50
BF2-4	5	30	60	5	0	variable	100	20	0.2	80	10	10
BF2-5	5	25	50	10	10	clear	250	15	0.25	80	15	5
BF3-1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
BF3-2	N/A	N/A	N/A	N/A	N/A	clear	400	N/A	N/A	N/A	N/A	N/A
BF3-3	40	30	20	0	10	N/A	N/A	N/A	N/A	N/A	N/A	N/A
BF3-4	15	75	5	0	5	clear	750	N/A	0.4	N/A	N/A	N/A
BF3-5	15	60	10	5	10	clear	400	N/A	N/A	20	0	80
BF4-1	5	80	5	10	0	0.75m	188	10	0.2	0	90	10
BF4-2	10	80	5	5	0	clear	351	8	0.25	20	70	10
BF4-3	0	20	40	40	0	0.5m	140	5	0.3	30	40	30
BF4-4	10	80	0	0	10	0.75m	500	5	0.25	40	0	60
BF4-5	5	70	10	10	5	0.2m	300	15	0.4	15	0	85

Table 2. Physical characteristics for all sites in the Lake Huron Tributaries surveyed in 2008. Substrate types are modified from Wentworth (1922): boulder is >250 mm in size, rubble is between 60-250 mm in size, gravel is between 20-50 mm in size, and sand is <20 mm in size. "Other" includes muck, mud, silt, and detritus.

Site	Substrate (%)					Water clarity	Site length (m)	Mean width (m)	Mean depth searched (m)	Stream morphology (%)		
	Boulder	Rubble	Gravel	Sand	Other					Riffle	Run	Pool
PG1	40	2.5	2.5	5	50	very poor	1330	3.25	0.65	35	45	20
PG2	0	30	30	0	40	poor	673	0.75	0.4	15	5	80
HA3	0	40	10	0	50	poor	1495	0.8	0.35	10	85	5
#4	NOT SURVEYED											
PG5	10	30	5	0	55	poor	300	3	0.75	25	70	5
#6	0	0	10	5	85	clear	903	2	0.15	40	20	40
#7	15	15	30	15	25	moderate	694	-	0.25	60	5	35
#8	15	15	30	10	30	moderate	457	1.5	0.2	40	50	10
#9	1	5	30	14	50	clear	964	2	0.15	35	60	5
#10	25	30	17.5	0	27.5	moderate	878	2	0.35	25	67.5	7.5
#11	NOT SURVEYED											
#12	0	15	35	35	15	clear	693	2	0.2	50	50	0
#15	5	7.5	12.5	7.5	67.5	poor	1021	2	0.15	7.5	75	17.5
#16	2.5	10	25	10	52.5	variable	968	2.5	0.1	35	50	15
#17	10	57.5	7.5	2.5	22.5	clear	940	6	0.35	27.5	65	7.5
#18	10	37.5	15	7.5	30	clear	917	8	0.45	27.5	62.5	10
#19	2.5	22.5	15	20	40	moderate	913	3	0.5	20	60	20
#20	12.5	17.5	17.5	0	52.5	poor	826	8	0.35	20	47.5	32.5
#21	7.5	30	12.5	7.5	42.5	poor	630	6	0.45	15	47.5	37.5

Table 3. Numbers of live specimens collected at all sites surveyed in the Bayfield River watershed in 2007 by Fisheries and Oceans Canada. BF1-1, BF1-3, BF2-1, and BF4-3[TC] are not included as no live mussels were present.

Species Name	BF1-2	BF2-2	BF2-3	BF2-4	BF2-5	BF3-1	BF3-2	BF3-3	BF3-4	BF3-5	BF4-1[BR]	BF4-2[BR]	BF4-4[BR]	BF4-5[BR]	Total
Amblema plicata	9	-	-	-	-	-	-	-	-	-	-	-	-	-	**9**
Alasmidonta viridis	-	-	-	-	-	-	-	1	-	-	-	27	-	-	**28**
Anodontoides ferussacianus	1	-	-	-	-	-	-	-	-	-	-	-	-	-	**1**
Lampsilis cardium	11	-	-	1	-	1	1	-	-	-	1	3	-	-	**18**
Lampsilis siliquoidea	23	1	1	11	34	22	138	150[A]	4	9	32	28	1	6	**460**
Lasmigona complanata	33	-	-	-	-	-	-	-	-	-	-	-	-	-	**33**
Lasmigona compressa	-	-	-	-	5	1	10	13	-	-	-	2	2	-	**33**
Lasmigona costata	15	-	-	2	-	-	3	10	-	-	3	3	-	-	**36**
Leptodea fragilis	34	-	-	-	-	-	-	-	-	-	-	-	-	-	**34**
Potamilus alatus	68	-	-	-	-	-	-	-	-	-	-	-	-	-	**68**
Pyganodon grandis	15	-	-	2	6	39	99	406[A]	-	14	3	2	-	26	**612**
Quadrula quadrula	1	-	-	-	-	-	-	-	-	-	-	-	-	-	**1**
Strophitus undulatus	-	-	-	1	-	-	6	8	-	-	-	-	2	-	**17**
Truncilla truncata	1	-	-	-	-	-	-	-	-	-	-	-	-	-	**1**
Utterbackia imbecillus	1	-	-	-	-	-	-	-	-	-	-	-	-	-	**1**
Villosa iris	-	-	-	3	-	-	21	4	-	-	3	2	-	-	**33**
Total	**212**	**1**	**1**	**20**	**45**	**63**	**278**	**592**	**4**	**23**	**42**	**67**	**5**	**32**	**1385**
Species Richness	**12**	**1**	**1**	**6**	**3**	**4**	**7**	**7**	**1**	**2**	**5**	**7**	**3**	**2**	

* represent species that are protected under the Provincial *Endangered Species Act*.
[BR] represents sites in Bannockburn River
[TC] represents sites in Trick's Creek
[A] represents an estimated total number. Large numbers of *L. siliquoidea* and *P. grandis* were observed at BF3-3, therefore these species were only collected for half of the sampling period. The number collected was multiplied by 2 to get an estimate of the number of individuals observed over the total sampling period

Table 4. Abundance and frequency of occurrence of all mussel species observed in the Bayfield River watershed in 2007.

Species	Abundance	Relative Abundance (%)	Frequency of Occurrence (%)
Amblema plicata	9	0.65	5.56
Alasmidonta viridis	28	2.02	11.11
Anodontoides ferussacianus	1	0.07	5.56
Lampsilis cardium	18	1.30	33.33
Lampsilis siliquoidea	460	33.21	77.78
Lasmigona complanata	33	2.38	5.56
Lasmigona compressa	33	2.38	33.33
Lasmigona costata	36	2.60	33.33
Leptodea fragilis	34	2.45	5.56
Potamilus alatus	68	4.91	5.56
Pyganodon grandis	612	44.19	55.56
*Quadrula quadrula**	1	0.07	5.56
Strophitus undulatus	17	1.23	22.22
Truncilla truncata	1	0.07	5.56
Utterbackia imbecillus	1	0.07	5.56
*Villosa iris**	33	2.38	27.78

* Protected under the provincial *Endangered Species Act*.

Table 5. Abundance and frequency of occurrence of all mussel species observed in the Lake Huron tributaries in 2008. All mussels were found at Site #21.

Species	Total Abundance	Relative Abundance (%)	Frequency of Occurrence (%)
Strophitus undulatus	1	11.11	5.26
Pyganodon grandis	8	88.89	5.26
Total	**9**		

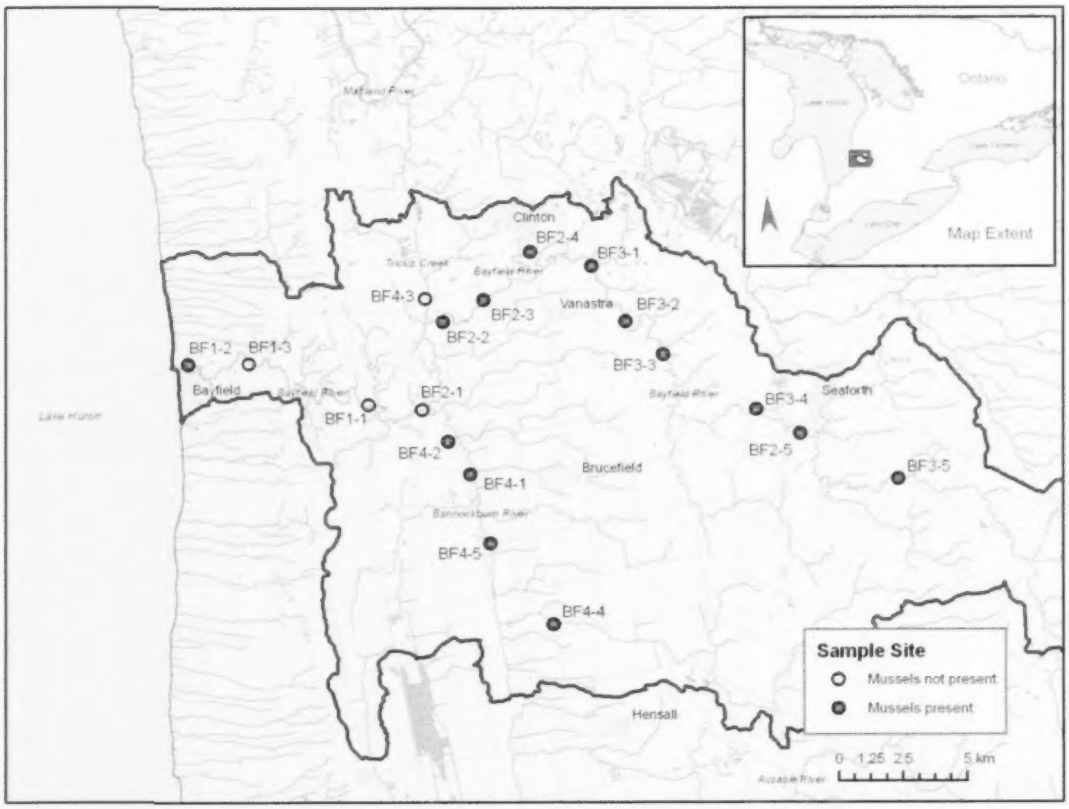

Figure 1. Eighteen sites surveyed by Fisheries and Oceans Canada in the Bayfield River watershed in 2007. Site number corresponds to numbers in the tables and appendices.

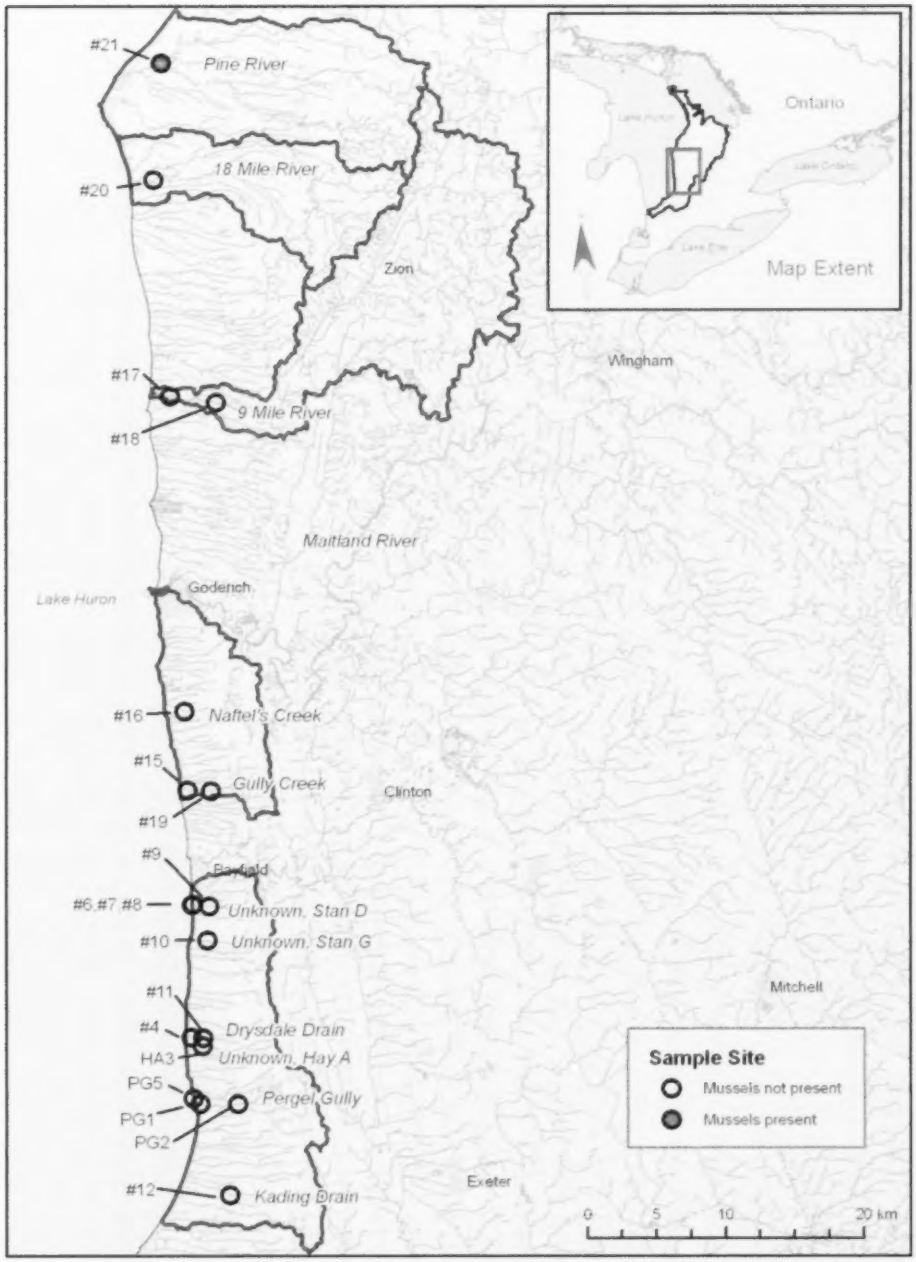

Figure 2. Nineteen sites surveyed by Fisheries and Oceans Canada in Lake Huron tributaries in 2008. Site number corresponds to numbers in the tables and appendices.

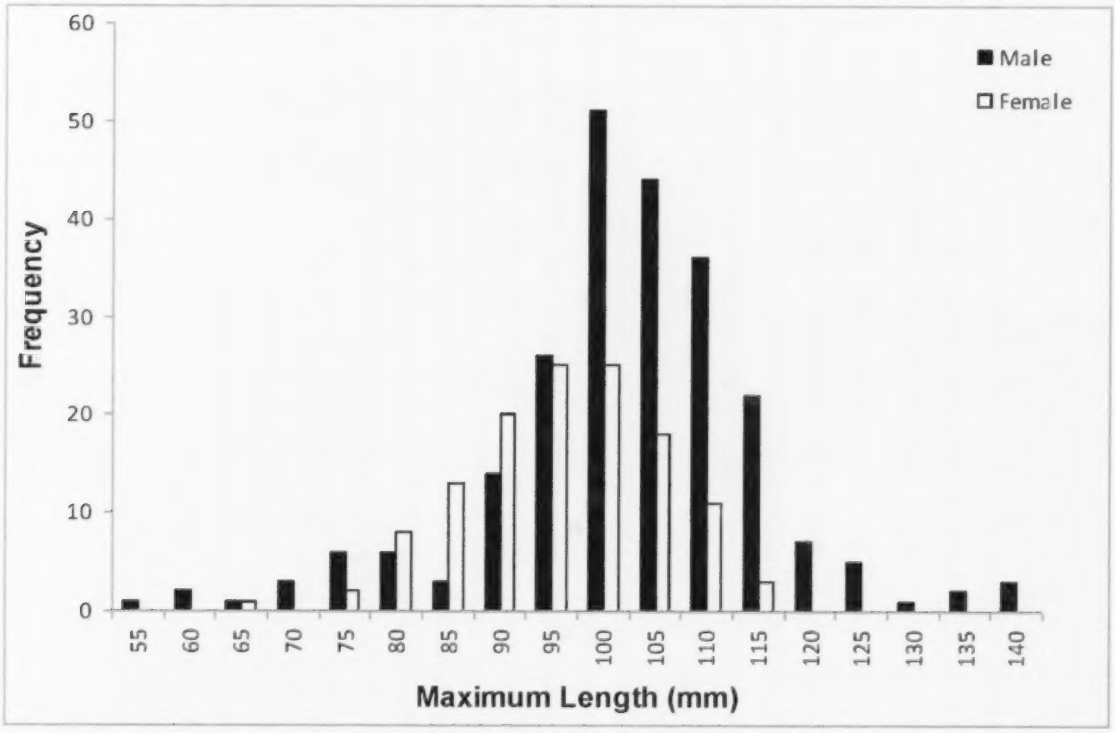

Figure 3. Length frequency distribution for male (233 individuals) and female (126 individuals) *Lampsilis siliquoidea* (Fatmucket) found in the Bayfield River watershed in 2007 by Fisheries and Oceans Canada.

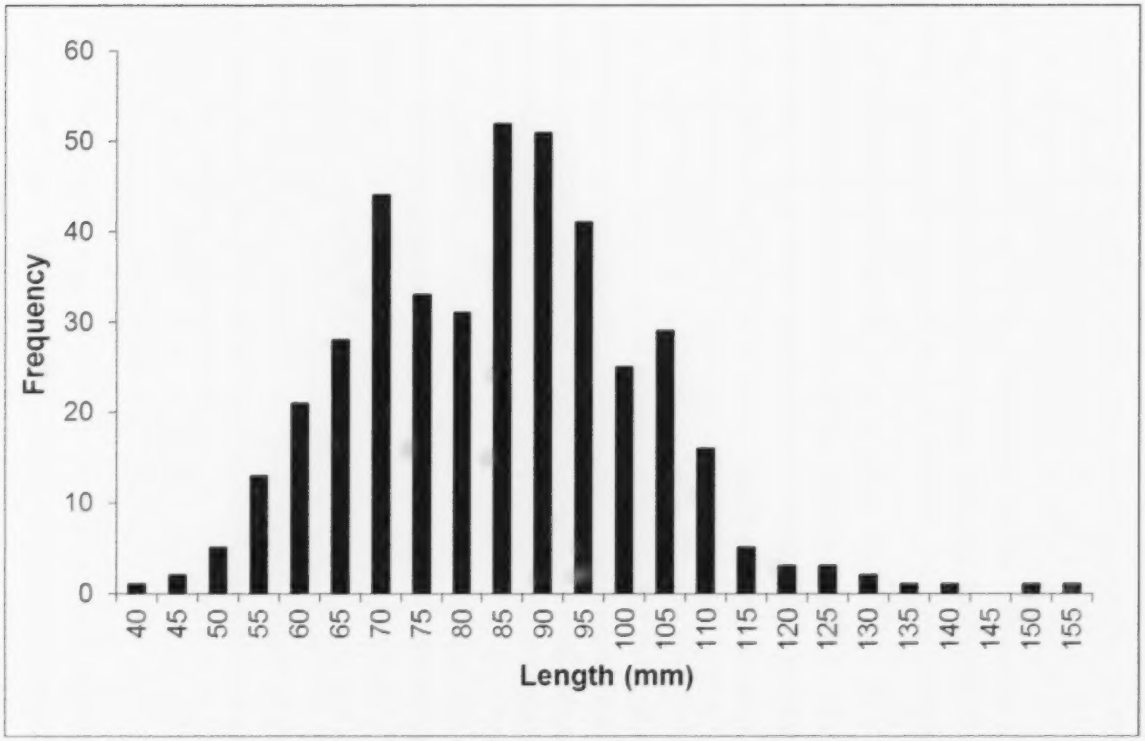

Figure 4. Length frequency distribution *Pyganodon grandis* (Giant Floater) found in the Bayfield River watershed in 2007 by Fisheries and Oceans Canada (n = 409).

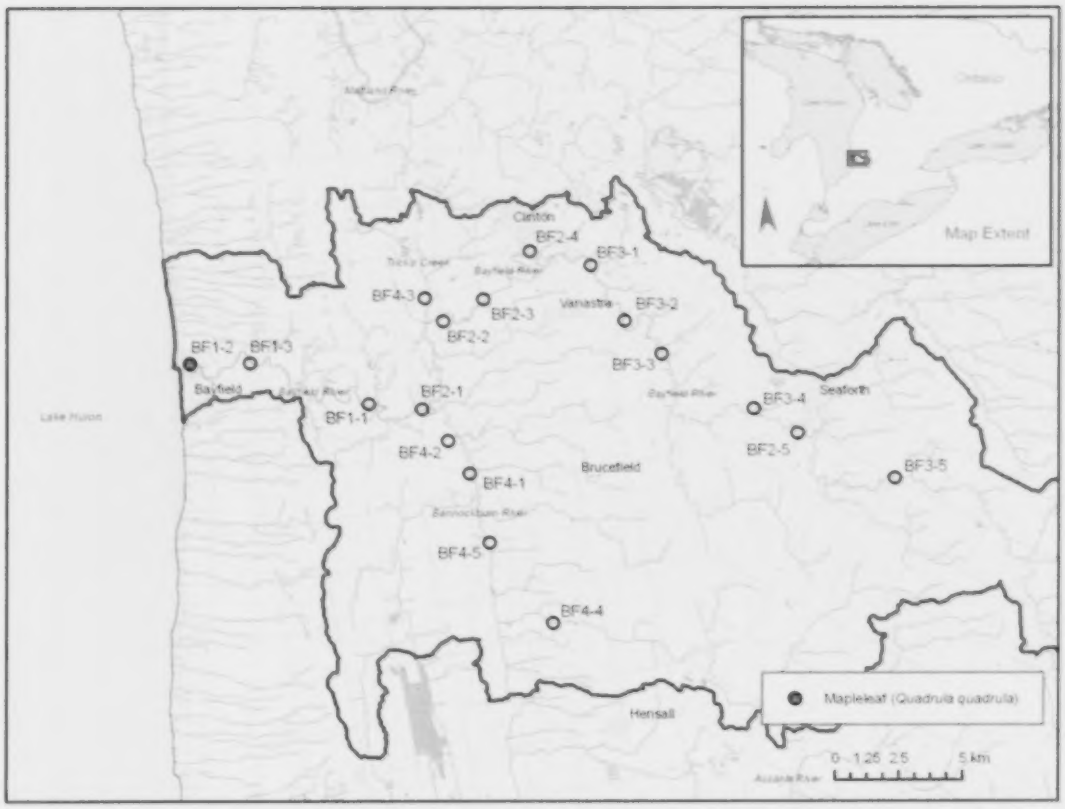

Figure 5. *Quadrula quadrula* (Mapleleaf) occurrence in the Bayfield River watershed during surveys by Fisheries and Oceans Canada in 2007. One individual was found at BF1-2. Site number corresponds to numbers in the tables and appendices.

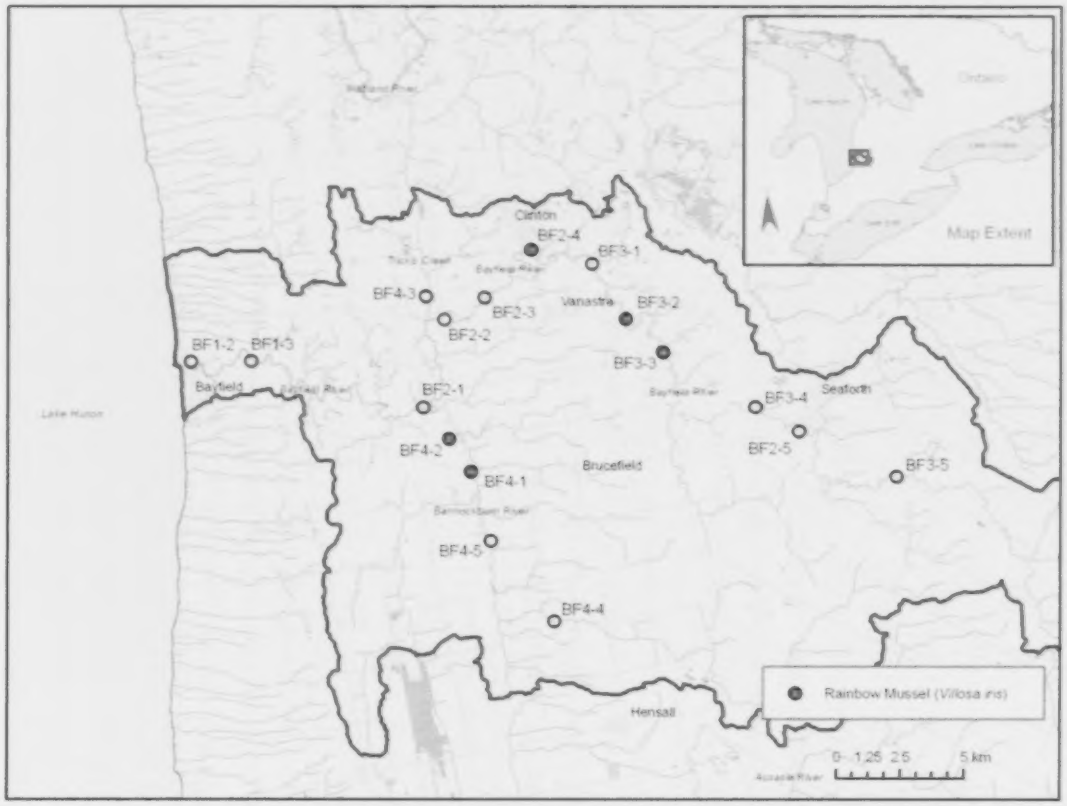

Figure 6. *Villosa iris* (Rainbow Mussel) occurrence in the Bayfield River watershed during surveys by Fisheries and Oceans Canada in 2007. For details on the number of individuals observed at each site see Table 3. Site number corresponds to numbers in the tables and appendices.

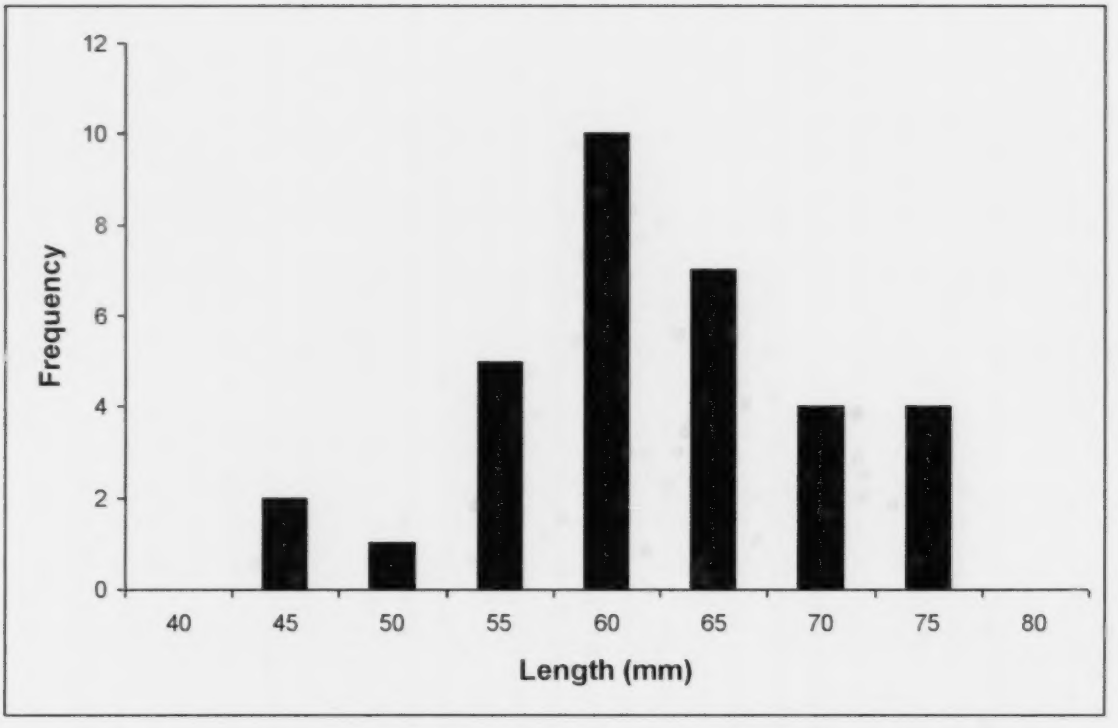

Figure 7. Length frequency distribution of *Villosa iris* (Rainbow Mussel) found in the Bayfield River watershed in 2007 by Fisheries and Oceans Canada (n = 33).

Appendix A. Locations of all sites surveyed in Bayfield River watershed in 2007 by Fisheries and Oceans Canada. Site descriptions and effort (number of person-hours searched) are included.

Site	Date	Latitude	Longitude	Waterbody	Local Description	Effort
BF1-1	24/07/07	43.55359	-81.61569	Bayfield River	Behind and upstream of Bayfield STP	4.5
BF1-2	24/07/07	43.57075	-81.70146	Bayfield River	Highway #21 immediately upstream of bridge	4.5
BF1-3	24/07/07	43.57009	-81.67243	Bayfield River	Wildwood trailer park	4.5
BF2-1	24/07/07	43.55095	-81.58995	Bayfield River	Parr line bridge, North of Varna	4.5
BF2-2	24/07/07	43.58196	-81.57808	Bayfield River	Bannockburn Line bridge, NE of Varna	4.5
BF2-3	24/07/07	43.58922	-81.55828	Bayfield River	Airport Line bridge, approximately 50 m downstream of bridge	4.5
BF2-4	25/07/07	43.60572	-81.53453	Bayfield River	Highway #4 bridge south of Clinton	4.5
BF2-5	25/07/07	43.53644	-81.40917	Bayfield River	Kippen Rd, downtown Egmondville bridge	4.5
BF3-1	24/07/07	43.59978	-81.5055	Bayfield River	Bridge at Front Rd, 2km east of Clinton	4.5
BF3-2	24/07/07	43.57932	-81.49032	Bayfield River	Sanctuary Line, 2km E of Vanastra	4.5
BF3-3	24/07/07	43.56679	-81.47317	Bayfield River	Kiburn Line and Front Rd, 4km E of Vanastra	4.5
BF3-4	25/07/07	43.54567	-81.42962	Bayfield River	Hannah Line just south of Front Rd	4.5
BF3-5	25/07/07	43.51862	-81.36298	Bayfield River	Front Rd and Perth Rd 183, 2km SE of Seaforth	4.5
BF4-1	24/07/07	43.5272	-81.5684	Bannockburn River	West of Brucefield	4.5
BF4-2	24/07/07	43.53908	-81.5782	Bannockburn River	Bannockburn Line and Roman Rd	4.5
BF4-3	24/07/07	43.59054	-81.58666	Trick's Creek	Bayfield Rd, 7km west of Clinton	4.5
BF4-4	25/07/07	43.47243	-81.53123	Bannockburn River	Airport Line below Staffa	4.5
BF4-5	25/07/07	43.50213	-81.56026	Bannockburn River	Centennial Rd and Bannockburn Line	4.5

Appendix B. Locations of Lake Huron tributary sites surveyed in 2008 by Fisheries and Oceans Canada. Site descriptions and effort (number of person-hours searched) are included.

Site	Date	Latitude	Longitude	Waterbody	Site Location	Local Description	Effort
PG1	23/06/08	43.406633	-81.706913	Pergel Gully	Zurich	-	4.5
PG2	23/06/08	43.40563	-81.67313	Pergel Gully	Zurich	East of PG1	4.5
HA3	23/06/08	43.445042	-81.70251	Unknown, Hay A	Zurich	2nd closest to Lake Huron	4.5
#4	23/06/08	43.450739	-81.71183	Drysdale Drain	Drysdale	-	0 (poor site)
PG5	23/06/08	43.410695	-81.71258	Pergel Gully	St. Joseph	Mouth of gully; @ end of Ravine Drive; access by public stairs	3 (reached PG1)
#6	24/06/08	43.53822	-81.70601	Unknown, Stan D	Wildwood	-	4.5
#7	24/06/08	43.5385	-81.70536	Unknown, Stan G	Houston Heights	-	4.5
#8	24/06/08	43.53835	-81.70636	Kading Drain	Ridgeway	-	4.5
#9	24/06/08	43.53701	-81.69104	Unknown, Stan D	-	2nd access after Wildwood	4.5
#10	25/06/08	43.5144	-81.6939	Unknown, Stan G	-	2nd access after Houston Heights	4.5
#11	25/06/08	43.45008	-81.70166	Drysdale Drain	-	2nd access from Beach	0 (dry, poor site)
#12	25/06/08	43.34569	-81.6842	Kading Drain	-	3rd access point (2nd too close to beach site)	4.5
#15	09/07/08	43.61398	-81.70565	Gully Creek	-	Off Highway 21	4.5
#16	09/07/08	43.66637	-81.70558	Naftel Creek	-	Off Highway 21	4.5
#17	09/07/08	43.87645	-81.70568	Nine Mile River	-	Off Highway 21	4.5
#18	09/07/08	43.87113	-81.664717	Nine Mile River	-	Lanesville Lane; 2nd access point from last site on river	4.5
#19	09/07/08	43.61295	-81.68472	Gully Creek	-	Off Orchard Line	4.5
#20	10/07/08	44.0217	-81.71192	18 Mile River	-	Off Highway 21	4.5
#21	10/07/08	44.09953	-81.70093	Pine River	-	Off Concession Road #6	4.5